ROBO ARM

NASA sends spacecraft equipped with robotic arms to explore places humans can't yet visit, like Mars and asteroids. These arms are strong and adaptable and are where a lot of work gets done—it's where many of the Mars rovers' tools live.

WE CHALLENGE YOU TO...

...design and build a Robo Arm that you can use to lift a cup off a table.

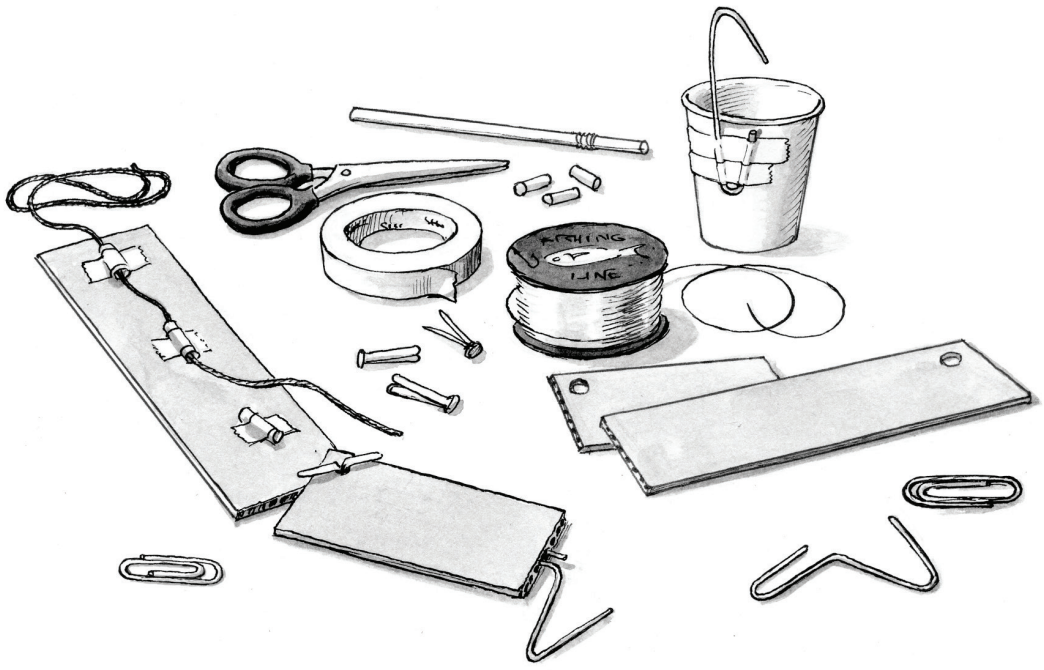
1. IDENTIFY THE PROBLEM AND BRAINSTORM

- How will you connect the cardboard strips so they pivot efficiently?
- Where will you tape the end of the string so that the "hand" moves the way you want it to?
- How can you use the straws as guides for the string?

2. DESIGN AND BUILD

Below are some Robo Arm ideas. Invent your own design or improve on one of these.

- **If the sections don't move freely...** Loosen the brass fasteners to reduce friction.
- **If the hand doesn't move in the direction it should...** Check where you taped the end of the string to the cardboard. Also check that the guides make the string pull in the right direction.



MATERIALS

- 1 large strip of corrugated cardboard (about 5 x 20 centimeters [2 x 8 inches]) Punch a hole in one corner.
- 1 small strip of cardboard (Cut a large strip in half.) Punch a hole in one corner.
- 1 medium (i.e., 1-inch) brass fastener
- 1 straw, cut into 2.5 centimeter (1-inch) lengths
- 100 centimeters (39 inches) of smooth string (e.g., fishing line)
- 2 large paper clips
- 2 paper cups (3-ounce)
- Tape (any kind)

WORDS TO USE

- **lever:** *A rigid bar attached to a pivot used to transmit force*
- **tension:** *A pulling, stretching force*
- **compression:** *A pushing, squeezing force*
- **friction:** *A force that resists motion*

3. TEST, EVALUATE, AND REDESIGN

- **Play Kick the Cup.** Lay your Robo Arm flat on the table. Put a paper cup by your arm's "hand." Pull the string quickly. How far you can kick the cup?
- **Pick up a target cup.** Add a hook to the end of your Robo Arm. Can you pick up the target cup?
- **Play Round Robin.** Have a few kids stand around a table. Use the Robo Arms to pass a cup all the way around. Can you do it faster?

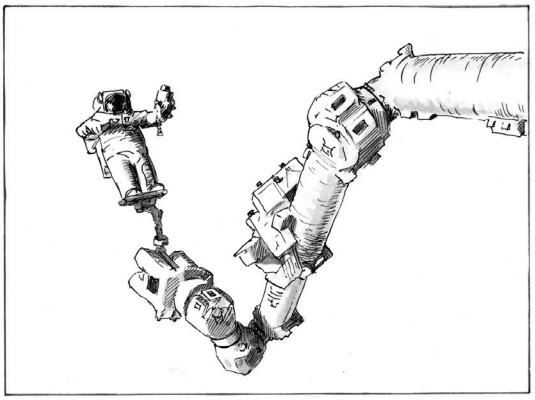
Check out NASA's missions at nasa.gov

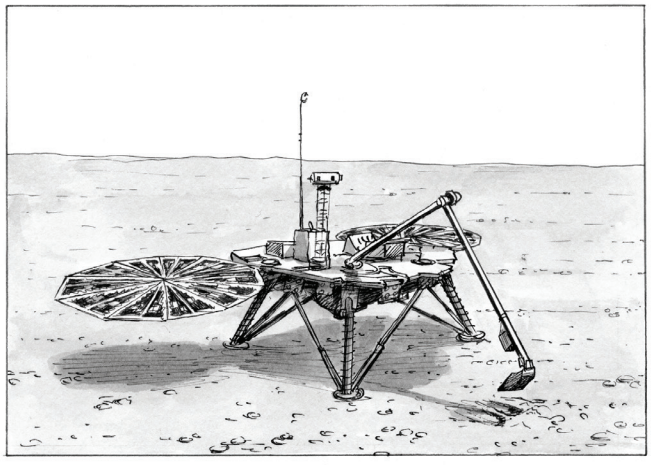
4. TRY THIS NEXT!

•Add a third section to the arm, like a person's upper arm.

NASA EXPLORES SPACE

The International Space Station has a robotic arm. It is 18 meters (58 feet) when fully extended and weighs 1800 kilograms (4,000 lbs). It moves equipment and supplies around the station, supports astronauts working in space, and services things like instruments. Because robotic arms are so versatile, many spacecraft use them, but they are much smaller than the one on the space station.





The Phoenix spacecraft reached Mars in 2008. It has a 2.4-meter (7.7-foot) robotic arm that dug into the soil to uncover a layer of ice. The arm dropped soil samples into instruments that checked for water and carbon-based chemicals—essential elements for life.

Visit the *Design Squad Nation* website at pbskids.org/designsquad.

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